ENGINEERING SOILS MAP OF HOWARD COUNTY

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BY

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JHRP

JOINT HIGHWAY RESEARCH PROJECT

PURDUE UNIVERSITY AND

INDIANA STATE HIGHWAY COMMISSION

Final Report

ENGINEERING SOILS MAP
OF HOWARD COUNTY INDIANA

TO: J. F. McLaughlin, Director
Joint Highway Research Project

June 17, 1969

File: 1-5-28-48

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-51B

The attached report, entitled "Engineering Soils Map of Howard County, Indiana," completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 48th report in the series. The report was prepared by Professor D. G. Shurig, Joint Highway Research Project.

The soils mapping of Howard County was performed primarily by using the soil survey field sheets published by the Soil Conservation Service, United States Department of Agriculture. Airphoto interpretation techniques were used to supplement the pedological data. The resulting engineering soils map is presented as a blackline print.

Respectfully submitted,

Harold L. Michael

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D. G. Shurig

Research Associate

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Project No: C-36-51B

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Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

Soil Conservation Service

U. S. Department of Agriculture

Purdue University
Lafayette, Indiana
June 17, 1969

ENGINEERING SOILS MAP

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INTRODUCTION

Development of an engineering soils map of Howard County (in back cover pocket of this report) was the primary objective of this project. The purpose of the following report is to supplement the information appearing on the engineering soils map.

In 1961 a group of Howard County citizens from various businesses and organizations joined with the Howard County Soil and Water Conservation District and the Purdue Cooperative Extension Service to plan the development of a detailed pedological map and report of the county. Most of the work was by and under the direction of J. M. Deal, Soil Scientist, Soil Conservation Service, Kokomo, Indiana and H. M. Galloway, Extension Agronomist, Purdue University.

In the field, soil scientists used 11-inch square aerial photographs to map pedological soils data in minute detail. The photographs, taken in 1957, have a scale of about 1:16,000 or about four inches to the mile. Copies of the photographs (soil survey field sheets) can be seen at the Soil Conservation office in Kokomo or in the office of the county highway engineer.

The attached engineering soils map (scale - one inch to one mile) was made primarily from the pedological data appearing on the numerous soil survey field sheets. Numerical symbols

on the field sheets indicate soil texture, soil catena, drainage profile, slope class, and erosional class according to USDA classification systems. The catena number, plus the drainage profile number, indicates the soil series. Delineating various individual soil series, and groups of soil series, was the primary technique used in making the engineering soils map at the back of this report.

The use of pedological data was supplemented with routine airphoto interpretation techniques. One day was spent in the field verifying judgements pertaining to pedological data and airphoto interpretation.

Field sampling was done by the USDA soil scientists. At each of the 12 sites sampled, samples for laboratory testing were usually taken from the A, B and C horizons. Due to the obviously bad construction characteristics of muck, peat, marl, and highly organic top soils, these materials were not sampled but were carefully mapped.

All samples were tested by the Joint Highway Research Project, Civil Engineering School, Purdue University. Grain size analysis, Atterburg limits and standard Proctor compaction characteristics were determined and the soils classified according to the American Association of State Highway Officials and the Unified Soil Classification System.

The engineering soils map was drawn using graphic symbols to delineate parent materials (grouped according to land form and origin). Textural symbols were superimposed on the parent material symbols to indicate relative composition of the parent

material soils. The map also carries a set of soil profiles showing the general soil profile of topographic high and low sites in each parent material area. Each profile shows the general range in depth and range in soil textures (ISHC soil textures) of each soil horizon.

DESCRIPTION OF AREA

GENERAL

Howard County is located in central Indiana - see Fig. 1. Kokomo, the county seat, is about 50 miles north of Indianapolis.

Howard County is 26 miles in the east-west direction and averages about 11.3 miles in the north-south direction. It has an area of 294 square miles.

Howard County is important for farming though there is a trend toward urbanization. Farming consists mainly of the cash-grain (corn, soybeans) and livestock types. The most common practice is to feed the crops to hogs and cattle and to market the livestock.

Census data from 1950 and 1960, shown below, indicates that the county population is increasing in both urban and rural areas.

TABLE I. SOME SIGNIFICANT POPULATION DATA FOR HOWARD COUNTY (2)

Population Cities and Towns	Population 1950	Population 1960	Population Change '50-'60
Greentown	1 160	1 266	106
Kokomo	38 762	47 197	8 435
Cities & Towns	39 922	48 463	8 541
Rural Areas	14 576	21 046	6 470
County Total	54 498	69 509	15 011

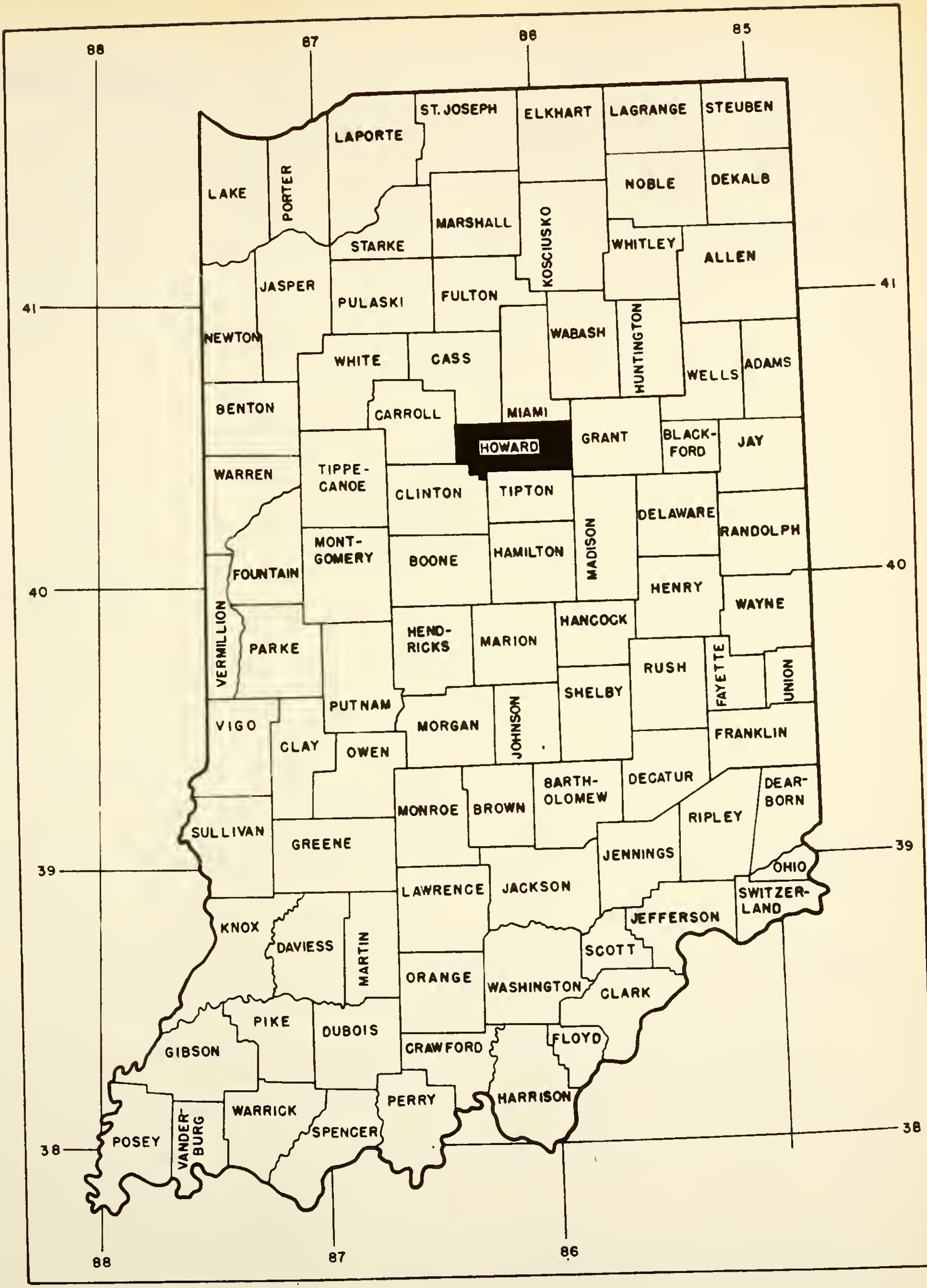


FIG. I. LOCATION MAP OF HOWARD COUNTY

DRAINAGE FEATURES

Fig. 2 shows a drainage map of Howard County (3). The county lies in the Wabash drainage basin of the State. The Wildcat Creek, a large tributary of the Wabash, has a watershed in Howard County that drains the southern two-thirds of the county. The northwestern and north-central parts of the county lie in the Deer Creek watershed and the northeastern part is in the Pipe Creek watershed.

The main creeks and their main tributaries in the county flow generally west while many small tributaries flow either generally north or south. Tributaries of the Wildcat Creek from the north are relatively short but those from the south are fairly long. Southern tributaries include the Little Wildcat Creek, Kokomo Creek and Honey Creek. Headwater streams of the Wildcat are located in Tipton County where flow is easterly. These streams combine and the resulting stream enters the southeast corner of Howard County and then changes course to a westerly direction.

Because the till plain is geologically young the drainage has not fully developed and most of it is quite poor except immediately adjacent to the larger creeks. The till plain area, especially in the northern half of the county, has many undrained basins. Many ditches have been constructed to improve sluggish drainage.

Some stream deflection can be attributed to the presence of the ridge moraines. Wildcat Creek and South Fork Deer Creek,

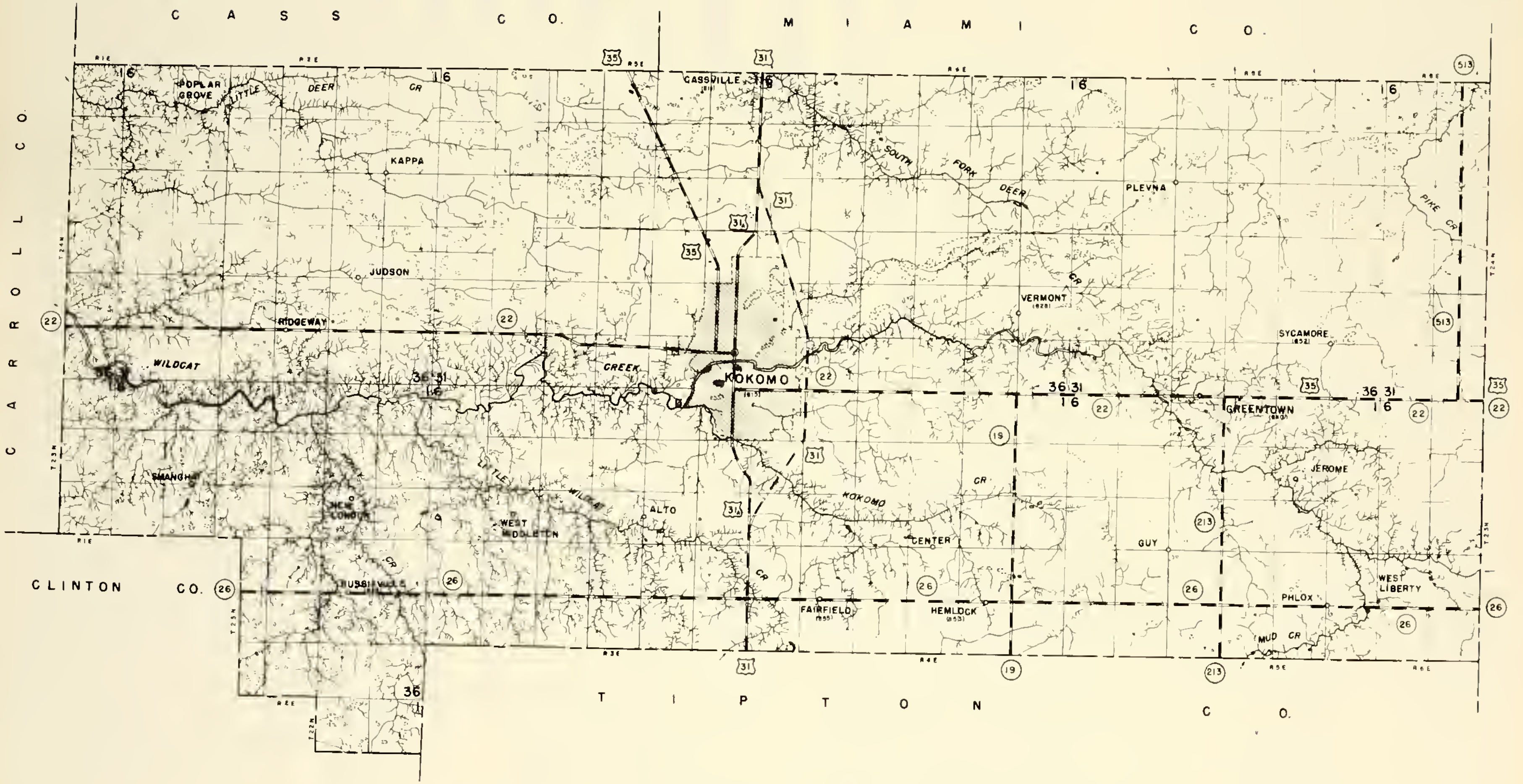


FIG. 2 DRAINAGE MAP OF HOWARD COUNTY.

in the eastern part of the county, are nearly parallel to the Union City Moraine. This moraine also produces a watershed divide in Howard County - see Fig. 2.

The Kokomo Waterworks Company has dammed the Wildcat three miles west of Kokomo. The reservoir is used as a water supply for the City of Kokomo and for recreational purposes.

CLIMATE

The climate of Howard County is continental, temperate and humid. The generally warm, humid summers and moderately cold winters are characterized by frequent sudden changes of temperture. The wide variations occurring within a season are indicated by the absolute minimum and absolute maximum temperatures listed in Table II.

GLACIAL GEOLOGY

Ice covered Howard County during at least three glacial ages: Kansan, Illinoian and Wisconsin. Thickness of the glacial drift deposited ranges from 50 to 150 feet over most of the county - see Fig. 3. A shallow, but conspicuous, buried channel is located north of the Wildcat Creek and approximately parallel to it. Greatest thickness of drift over the center of the old preglacial channel is about 200 feet. Drillers report that the channel drift contains considerable muck, silt, black muddy sand and wood fragments (4). In and near Kokomo the Wildcat Creek and the Kokomo Creek have cut through the drift to limestone bedrock in a number of places.

TABLE II

AVERAGE MONTHLY AND ANNUAL TEMPERATURES AND PRECIPITATION

Month	Temperature Avg. Deg. F	Max. Deg.	Min. Deg.	Precipitation Avg. In.	1 in 10 yrs. less than	1 in 10 yrs. more than
Jan.	29	69	-20	2.6	0.7	5.9
Feb.	31	72	-19	1.9	0.6	3.4
Mar.	41	85	-6	3.4	1.6	6.3
Apr.	52	90	18	3.6	1.9	5.9
May	62	96	28	4.1	1.7	6.9
June	71	103	36	4.0	1.6	7.7
July	75	105	42	3.7	1.2	6.4
Aug.	73	103	39	3.5	1.6	5.5
Sept.	68	103	26	3.3	0.8	6.4
Oct.	56	92	15	2.6	0.9	4.8
Nov.	43	81	-4	2.9	1.2	4.9
Dec.	32	68	-15	2.4	0.6	4.2
Year	53	105	-20	38.0	30.4	45.8

The following is quoted from a geologist's report on Howard County written in 1900: "It is a clay county, at least 90 percent of the surface being a yellow clay. There is no sign of surface gravel or sand anywhere and there are no wells which get into sand or gravel short of ten feet. Just beneath the yellow clay there is a blue till which runs down to the underlying limestone where the depth of the limestone is not more than 50 feet. Where the drift is thicker than 50 feet, there seems to be a large gravel bed in which the better wells of the county find their water." (5).

Since this report was in 1900 some sand and gravel deposits have been found at a depth shallower than the stated ten feet.

Wisconsin Age drift appears on the surface and it includes material deposited during two subages - the older Tazewell, and the younger Cary. The Tazewell drift covers the whole county and Cary drift overlies it only in the northeastern corner, up to and including the Union City Moraine.

"Cary till [in the northeast] is heavy textured, dark gray, blocky and clayey. It commonly breaks with a nearly cubic fracture and when moist is much more plastic than earlier till. Sand-size material is sparse throughout, and few cobbles and boulders are present. Unweathered Tazewell till is pale gray, bouldery, calcareous and generally contains a large amount of quartz sand which appears to decrease in quantity southward." (6).

Shortly after glaciation most of the county was mantled with loess. In the west the mantle is about 40 inches deep but decreases in thickness to the east.

BEDROCK GEOLOGY

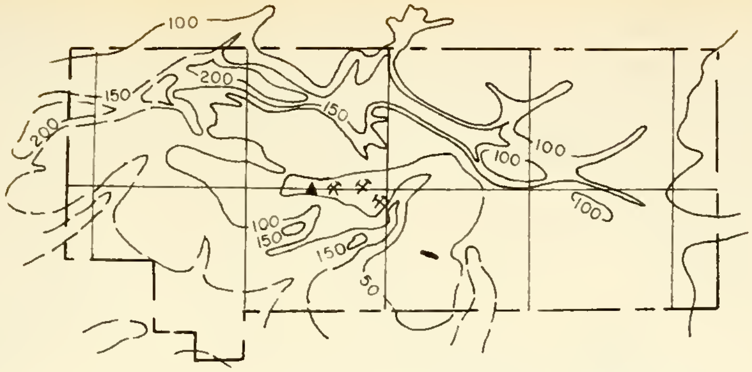
Fig. 3 shows a generalized bedrock geology map of Howard County (7) and the approximate depth of overburden. A more recent geologic map (Regional Geologic Map No. 2, Danville Sheet, 1966), however, shows the bedrock conditions slightly different. The Devonian rock mass, indicated in Fig. 3 to be underlying Kokomo, is moved south of Kokomo on the new map. The new map shows Silurian rock underlying all the rest of the county rather than some Devonian on its northern and eastern edges. The Silurian Members at the bedrock surface are: Kenneth Limestone, Kokomo Limestone, Liston Creek Limestone and Mississinewa Shale.

The Yeoman Stone Company, 1.5 miles west of Kokomo produces crushed limestone, crushed gravel and flagstone. This quarry showed the following section (1968): 40 feet of glacial drift, 26 feet of Kokomo limestone and 16 feet of Liston Creek limestone (8). This quarry is the only major operating limestone quarry in the county at the present time.

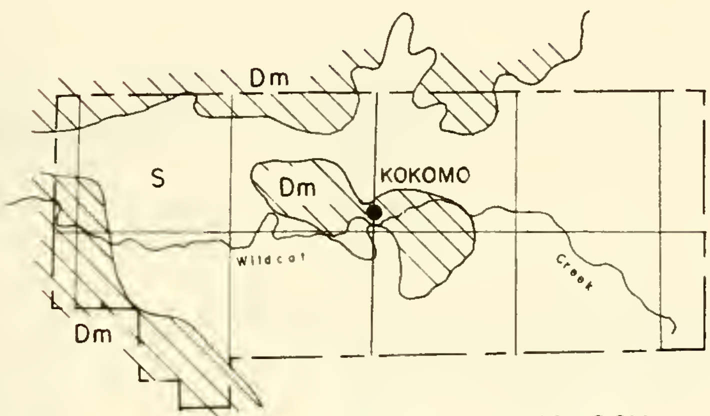
PHYSIOGRAPHY AND TOPOGRAPHY

Howard County lies in the Central Lowland Province of the United States and in the Till Plains Section of the province. In Indiana the Till Plains Section is known as the Tipton Till Plain.

Most of the ground surface is gently undulating till plain. The attached engineering soils maps show the very low Union City ridge moraine crossing the northeastern corner of the county and the Bloomington ridge moraine just inside a southwesterly projection of the county. The highest knolls in these areas have maximum relief of only around 20 feet and slopes are long and



GLACIAL DRIFT THICKNESS
(WAYNE - 1956)



BEDROCK GEOLOGY
(PATTON - 1956)

50 Ft. Contour Interval

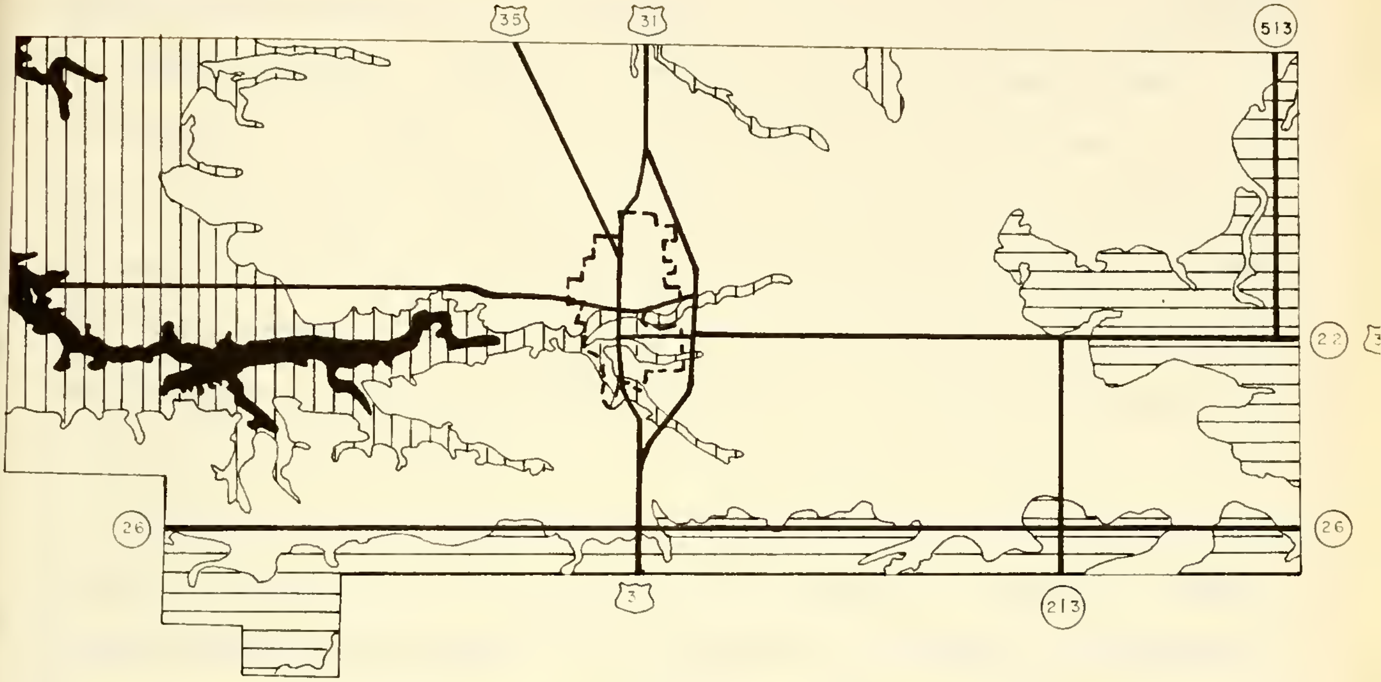
▲ Bedrock Outcrops

⚒ Quarry

S — Silurian Ls., Dolo., and Sh.

Dm — Middle Devonian Ls., Dolo., and Ss.

FIG. 3 GLACIAL DRIFT THICKNESS MAP AND BEDROCK GEOLOGY MAP.



KEY

CONTOUR INTERVAL 50 FEET

700 - 750

750 - 800

800 - 850

850 - 900

FIG. 4: TOPOGRAPHIC MAP OF HOWARD CO.

gentle. Long, narrow alluvial plains are the only other outstanding land forms in the county.

In the southwestern quadrant of the county the Wildcat Creek and its tributaries have entrenched themselves some 55 feet below the plain surface. Erosion adjacent to these streams within a half mile to one mile, has produced a rolling topography. In most of the county, however, maximum relief around most streams is not over 20 feet. A glance at the drainage map, Fig. 2, shows that most stream dissection is in the southern half of the county. The map shows numerous undrained basins in the north which attest to its greater flatness.

The topography map, Fig. 4, shows that the western portion of the Wildcat Creek lies in a valley around elevation 750 feet. Most of the plain surface of the county is between elevations of 800 and 850 feet. The highest elevations, above 850 feet, are along the eastern and southern sides of the county.

ENGINEERING SOIL AREAS

The soils of Howard County can be divided into three major groups: (1) glacial or ice-contact deposits, (2) fluvial or water-deposited materials and (3) miscellaneous deposits. In the discussion that follows each of the major groups is further subdivided into land form parent-material groups. These groups are then subdivided into soil textural groups.

I. GLACIAL DEPOSITED MATERIALS

The land forms of glacial, or ice-contact deposits in Howard County, include ground moraines, ridge moraines and kames. The latter, however, are so small and nearly mined out that they do not appear on the attached soils map.

The ground moraines and ridge moraines of Howard County can be discussed together because: (1) their parent materials are essentially the same, (2) the ridge moraines have relief only slightly higher than the ground moraines, and (3) the ridge moraines are of relatively small areal extent in the county.

(1) Ridge and Ground Moraines - Clayey Texture

The Union City ridge moraine, extending northwest-southwest across the northeast corner of the county, is a very low, poorly developed and poorly defined ridge moraine. Greentown and the northwest-trending portion of the Wildcat Creek lie on the western edge of the ridge moraine. Ground moraine, with the same parent material as that of the ridge moraine, lies in the northeast corner of the county.

The parent material of the northeast ridge and ground moraine is a moderately plastic to highly plastic clay mainly from former glacial lakes in the northern part of Indiana and Ohio. Clay content of the parent material ranges from about 35 to 55 percent, whereas clay contents of tills west of the Union City ridge moraine range from about 30 to 40 percent.

Most always the clay soil component in each horizon predominates but occasionally one or the other of the horizons is found to be silty. Most soils classify as clays or clay loams. The clayey layers are either moderately plastic clays or highly plastic clays. The majority of these clays are also elastic. The clays are elastic for any one or all three of the following reasons: (1) the presence of one-size silt particles, (2) organic matter or (3) lime carbonate.

Pedologically the clayey soils are Blount, Morley and Pewamo. Though no samples were taken for engineering soil tests in Howard County, engineering test data for these soil series, sampled in Allen and Delaware Counties, appears in the back of this report.

(2) Ground and Ridge Moraines - Clayey and Silty Textures

The clayey and silty ground and ridge moraines are found in the western two-thirds of the county - on the west side of the Union City ridge moraine. Though all the morainic materials in the county are generally clayey the western soils are slightly less plastic (less clayey and more silty) than soils in the eastern third of the county. The parent materials in the west are primarily loams and clay loams (Tazewell Age glacial drift).

The northwestern third of the county has a mantle of loess (wind blown silt) ranging from 18 to 40 inches thick. In the central third of the county, the loess mantle decreases in thickness to the east but the average thickness is about

18 inches. The surface layer of loess usually classifies as a silt loam.

The B horizon, usually a clay or silty clay, contains more clay than either the A or C horizon and is the most plastic and most impervious of the three layers.

Pedologically the soils are predominantly Brookston, Crosby and Miami. The last pages of this report show considerable engineering soil test data for each of the horizons of these soils as sampled in Howard County and/or adjacent counties.

II. FLUVIAL DEPOSITED MATERIALS

The fluvial deposited soils in Howard County are grouped and tabulated below according to their land form and parent-material texture.

Alluvial Plains
  Silt and Sand
Terraces and Outwash Plains
  Sand and Gravel
Valley Trains
  Silt and Sand

(1) Alluvial Plains

Wildcat Creek, running generally east-west across the central part of the county, has the greatest floodplain area of all the streams in the county. In the east the Wildcat alluvial plains run up to several hundred feet wide, but in the west they range between one and two thousand feet wide. Also in the east the Kokomo Waterworks Reservoir covers a length of about five miles of the alluvial plains. In the Kokomo area, limestone bedrock comes to within a few feet of the surface and in a number of these places it is or was quarried.

Narrow alluvial plains are found along the four southerly branches of the Wildcat and also along Deer Creek in the northwest, along South Fork of Deer Creek in the north central area and along Pike Creek in the northeast.

The alluvium is primarily silt and sand. There are variable layers of thin stratified fine sandy loams, fine sands, loams, silts and silty clay loams. Significant organic deposits are essentially nonexistent or too small to map in the alluvial areas. Within the alluvial boundaries, on the attached engineering soils map, annual flooding should be anticipated.

Pedologically the soils of the alluvial areas are: Genessee, Eel, Shoals and Sloan. Engineering soil properties of each of these soils is shown in Table III.

(2) Terraces - Sand and Gravel Texture

In general, stream terraces in Howard County are relatively sparse - most stream valley areas contain only alluvium. Terraces along streams, other than the Wildcat, are also relatively small. Most terraces are only five to 20 feet above the floodplains and most of them are or have been mined for sand and gravel.

The greatest concentration of terraces is along the western half of the Wildcat Creek. Because the Wildcat is the largest stream in the county, its terraces are the largest and most numerous. Some of these terraces grade into outwash plains on the upland and a few of them are possibly kame terraces rather than ordinary stream terraces.

Parent material of the terraces is stratified sand and gravel usually found at a depth ranging from six to 70 inches. When at or near the deeper depth, it is possible that part of the overburden may be up to 40 inches of loess. The parent material is usually a dirty granular material and there is usually more sand than gravel. Quantative soils data is found in Table III under the pedological soil names: Fox, Rodman, Ockley and Westland.

(3) Outwash Plains - Sand and Gravel Texture

Most of the outwash plains are in the extreme western part of the county along the Wildcat Creek. All the western outwash plains are adjacent to streams but on the uplands. Because of their location adjacent to stream valleys, the outwash plains have been somewhat dissected due to the normal erosion processes along streams.

The outwash plains are not well developed. They do not have sharp boundaries, the number and size of infiltration basins are minimal and some drainage gullies appear. The western part of the county is also known to have a mantle of about 40 inches of loess where it has not been eroded.

Some of the outwash plains contained some small kames, but mining operations have reduced their size so that they are now too small to map. Also in some places, where the outwash plains border on streams, there appears to be some small,poorly defined kame terraces. At a few places the outwash plains abut ordinary stream terraces.

Though the outwash plains described below are said to have a sand and gravel texture, there is undoubtedly considerably more sand than gravel and the percentage of fines is probably well over 10 or 15 percent. It also appears that most of the granular material is at least several feet deep and deposit thickness may range upward from only a few inches.

The largest outwash plain lies in the southwestern part of the county about one and one-half miles west of the junction of Wildcat and Honey Creeks. This somewhat dissected area of outwash material, lying about 50 feet above the floodplain of the Wildcat, may have been an old terrace of the Wildcat. Infiltration basins in the area are not pronounced or strong and so the quanity and/or quality of the granular material may be lacking. Several small kames in the area have been or are being mined.

Outwash plains along the Wildcat, within three miles farther west, have similar features and the granular materials do not appear promising for aggregate.

South of Kokomo, along the Little Wildcat Creek, a combination land form area of outwash plains (largest area), terraces and kames contains two of the largest operating sand and gravel pits in the county.

Another outwash area in the northwestern part of the county, along the southern branch of Deer Creek, also appears to have only weak features of a good granular outwash material. On the extreme western edge of this area is a small kame (too small for mapping) that is or was mined.

Pedologically the outwash soils are Fox, Rodman, Ockley and Westland. Their engineering soil characteristics are shown in Table III.

(4) Valley Trains - Silty and Sandy Texture

There are three, short narrow valley trains (valley fill) in the county. These were once glacial sluiceways which first carried channelized meltwater. Shortly thereafter the meltwater deposited a small amount of silty and sandy glacial outwash material. The old sluiceways do not have recent streams and so do not contain recent alluvium.

The longest valley train is about four miles long and forms the upper reaches of Kokomo Creek in the southeastern part of the county. Two shorter valley trains are found in the northwestern quadrant of the county - one forms the upper channel of a branch of Little Deer Creek and the other is in the upland and ends in a peat and muck basin area. These valley train areas are usually ditched for the purpose of concentrating and leading away runoff.

The soils are stratified silts and fine sands. Pedologically they belong to the Mahalasville, Whitaker and Needham soil series. Engineering soils data on each is found in Table III.

MISCELLANEOUS MATERIALS

(1) Peat and Muck

Most of the peat and muck deposits in the county lie in an abandoned shallow sluiceway about five miles long and one mile wide running northeasterly from the northeastern edge of Kokomo

to the front edge of the Union City ridge moraine. There is a cluster of deposits several miles to the northwest of Kokomo that have sizes up to a third of a mile in diameter. Much smaller deposits are sparsely scattered over the whole county. Peat and muck materials should be removed from essentially all construction sites.

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Soil Series	De Su In	Opt. MC %	LL %	PI %
Blount	0	23	34	11
(modal)	18	22	54	32
NESE 8, T22N, R10E	27	18	36	16
R10E Delaware Co.				
Blount	0	22	32	13
NENW 9	19	23	53	27
T22N R11E	32	19	45	23
Delaware Co.				
Brookston	0	24	46	19
(modal)	31	18	43	21
SWNE 5,T23N R4E	59	10	23	9
Howard Co.				
Brookston	0	23	47	20
NENE 30, T 23N R4E	19	20	48	24
Howard Co.	44	12	22	6
Carlisle	0			
over 42" thick,	17	ls before suitable for construction.		
variable substrata				
Celina *	0	--	--	--
	12	--	--	--
		--	--	--
Crosby (modal)	0	24	33	10
SESE 24, T23N,	20	22	57	32
R4E. Howard Co.	41	12	27	11
Crosby (modal)	0	20	29	6
NWSW 23, T23N, R4E	12	22	54	30
Howard Co.	31	12	25	10

TABLE III ENGINEERING TEST DATA FROM HOWARD COUNTY OR FROM OTHER INDIANA COUNTIES

Soils marked * do not have test data up to January 1, 1965. Values for these soils are from S.C.S. tables of estimated physical and chemical properties (Table III issued November 1964)

Soil Series	Depth from Surface Inches	Classifications USDA	Unified	AASHO	Percentage Passing Sieve #4	#10	#40	#200	Max. Dry Density lb/cu. ft	Opt. MC %	LL %	PI %
Blount	0-10	sil.	CL or OL	A-6(8)	100	100	97	93	96	23	34	11
(modal)	18-27	sic.	MH	A-7-5(19)	100	100	100	99	99	22	54	32
NESE 8, T22N, R10E	27-33+	sicl. (till)	CL	A-6(10)	100	99	98	97	106	18	36	16
R10E Delaware Co.												
Blount	0-6	sil.	CL or OL	A-6(9)	100	99	94	87	98	22	39	13
NENW 9	19-32	sic.	MH-CH	A-7-6(17)	100	98	96	89	98	23	53	27
T22N R11E	32-44	sicl.	CL	A-7-6(14)	98	95	91	85	104	19	45	23
Delaware Co.												
Brookston	0-8	sicl.	ML or CL,OL	A-7-6(13)	99	98	95	83	96	24	46	19
(modal)	31-51	sicl.	CL	A-7-6(13)	98	97	93	85	106	18	43	21
SWNE 5.T23N R4E	59-66	loam (till)	CL	A-4(5)	97	94	86	58	126	10	23	9
Howard Co.												
Brookston	0-3	sil. to sicl.	ML or CL,OL	A-7-6(13)	100	99	96	85	96	23	47	20
NENE 30, T 23N R4E	19-29	sicl.	CL	A-7-6(15)	100	99	98	92	102	20	48	24
Howard Co.	44-60	loam to cl.	ML - CL	A-4(5)	99	95	84	62	120	12	22	6
Carlisle	0-17	Muck	Pt		No engineering values for mucks							
over 42" thick,	17-45	Muck	Pt		Must be removed and backfilled with select materials before suitable for construction.							
variable substrata												
Celina *	0-12	sil.	ML	A-4	100	100	90-95	85-95	--	--	--	--
	12-36	sicl.	CL	A-6	100	95-100	85-95	80-95	--	--	--	--
	36+	loam till.	ML or CL	A-4 or A-6	100	95-100	70-80	60-70	--	--	--	--
Crosby (modal)	0-10	sil.	ML - CL	A-6(8)	99	98	94	85	96	24	33	10
SESE 24, T23N,	20-31	sicl.	CH	A-7-6(19)	--	100	98	94	98	22	57	32
R4E Howard Co.	41-48	loam (till)	SC	A-6(3)	86	81	73	47	124	12	27	11
Crosby (modal)	0-7	sil.	ML - CL	A-4(8)	100	99	95	85	103	20	29	6
NWSW 23, T23N, R4E	12-17	sicl.	CH	A-7-6(19)	--	100	99	98	100	22	54	30
Howard Co.	31-42	loam (till)	CL	A-4 or A-6(5)	95	90	82	58	123	12	25	10

Soil Series	De Su In	Opt. MC %	LL %	PI %
Eel Variable *	0	--	--	--
Substrata	10	--	--	--
below 30"		--	--	--
Fincastle *	0	--	--	--
	14	--	--	--
	32	--	--	--
		--	--	--
Fox	3	16	28	6
SENW 11	21	17	48	21
T20N, R6E	29	13	46	20
Madison Co.	36	10	NP	NP
Fox	3	18	32	10
SWNW 16, T19N, R8E	23	16	36	16
Depth to gravel	34	16	47	19
nearly like Ockley	41	11	NP	NP
Genesee Composite of 3 samples Owen Co. Sampled to from 42 to 74 inches	0	-16	26-31	6-[illegible]
Hennepin *	0	--	--	--
	8	--	--	--
		--	--	--
Kendallville *	0	--	--	--
	10	--	--	--
		--	--	--
Kokomo *	0	--	--	--
	12	--	--	--
	42	--	--	--
Landes *	0	--	--	--
	12	--	--	--
		--	--	--
Linwood *	0			
Mineral soils variable below mucks	18	--	--	--

TABLE III (Continued)

Soil Series	Depth from Surface Inches	Classifications USDA	Unified	AASHO	Percentage Passing Sieve #4	#10	#40	#200	Max. Dry Density lb/cu. ft	Opt. MC %	LL %	PI %
Eel Variable *	0-10	sil.	ML	A-4	100	100	95-100	85-95	--	--	--	--
Substrata	10-30	sil. or lt. sicl.	ML or CL	A-4	100	100	95-100	60-80	--	--	--	--
below 30"	30+	variable	ML, CL, SM	A-4 or A-2	100	90-100	70-90	40-80	--	--	--	--
Fincastle *	0-14	sil.	ML	A-4	100	95-100	95-100	85-95	--	--	--	--
	14-32	sicl.	CL	A-6	100	95-100	90-95	85-95	--	--	--	--
	32-60	cl.	CL	A-6	100	95-100	75-85	65-75	--	--	--	--
	60+	Loam	ML or CL	A-4	100	95-100	75-85	60-70	--	--	--	--
Fox	3-11	sil.	ML - CL	A-4(7)	99	98	88	69	109	16	28	6
SENW 11	21-29	sicl.	SM - SC	A-7-6(7)	83	76	57	48	104	17	48	21
T20N, R6E	29-36	Grav. cl.	SM - SC	A-2-7(1)	73	63	43	27	108	13	46	20
Madison Co.	36-50+	sand & gravel	SW - SM	A-1-6([illegible])	68	55	20	6	132	10	NP	NP
Fox	3-11	sil.	ML - CL	A-4	100	100	96	82	103	18	32	10
SWNW 16, T19N, R8E	23-34	sicl.	CL	A-6	95	90	75	58	110	16	36	16
Depth to gravel	34-41	gravel. cl.	SM - SC	A-2-7	64	53	35	26	108	16	47	19
nearly like Ockley	41-60+	sand & gravel	GW	A-1	50	28	8	5	127	11	NP	NP
Genesee Composite of 3 samples Owen Co. Sampled to from 42 to 74 inches	0-74	sil. & loam	ML - CL	A-4(8)	100	99-100	98-100	74-92	111-114	14-16	26-31	6-9
Hennepin *	0-8	loam	ML	A-4	100	95-100	80-100	60-70	--	--	--	--
	8-18	cl.	CL	A-6	100	95-100	80-95	65-75	--	--	--	--
	18+	loam to cl.	ML or CL	A-4 or A-6	100	95-100	90-100	60-70	--	--	--	--
Kendallville *	0-10	loam	ML	A-4	100	95-100	70-80	60-70	--	--	--	--
	10-36	scl. or cl.	SC or CL	A-4 or A-6	95-100	90-100	90-100	35-70	--	--	--	--
	36+	loam to lt. cl.	ML or CL	A-4 or A-6	95-100	90-100	70-85	60-70	--	--	--	--
Kokomo *	0-12	sicl.	CL	A-6 or A-7	100	95-100	90-100	80-90	--	--	--	--
	12-42	cl. to sicl.	CL or CH	A-7	100	95-100	95-100	75-90	--	--	--	--
	42-50+	loam	ML or CL	A-4 or A-6	100	85-95	75-85	55-70	--	--	--	--
Landes *	0-12	fsl	SM	A-2	100	100	85-95	25-35	--	--	--	--
	12-30	sl. or lfs	SM	A-2	100	100	85-95	15-25	--	--	--	--
	30+	sl., lfs., or loam	SW or SM	A-3	95-100	95-100	80-90	10-25	--	--	--	--
Linwood *	0-18	muck	Pt	A-4 or A-6	No engineering values for mucks.							
Mineral soils variable	18-38	silt loam	ML or CL		100	95-100	90-100	70-80	--	--	--	--
below mucks	38+	loamy mineral soil										

Soil Series	pt.	LL %	PI %
Mahalasville *		--	--
		--	--
		--	--
		--	--
Miami (modal)		27	4
NWSE 29.T24N, R4E		36	19
Howard Co.		16	2
Miami		32	10
NWNE 8 T24N, R4E		37	17
Howard Co.		22	9
Morley (modal)		32	7
NENE 31 T30N. R12E		46	19
Allen Co.		33	13
Morley (composite of	24	28-47	6-15
5) 3 Allen Co., 2	22	40-55	19-31
Delaware Co.	17	29-44	13-24
Needham *			
Ockley (modal)		26	9
SWSW 35, T13N, R5E		60	42
Shelby Co.		NP	NP
Ockley (composite of		26-32	9
modal and SWNE 14, T13N,	18	47-60	27-42
R5E	12	NP	NP
Pewamo (modal)		50	18
NWSW 9, T22N, R10E		49	28
Delaware Co.		38	19
Pewamo (composite of 5)	22	37-44	11-27
3 Allen Co., 2	20	37-52	18-33
Delaware Co.	20	24-42	10-24
Rifle			
over 42" acid	before suitable for construction.		
fibrous peat			
Rodman *		--	--
		--	--
		--	--

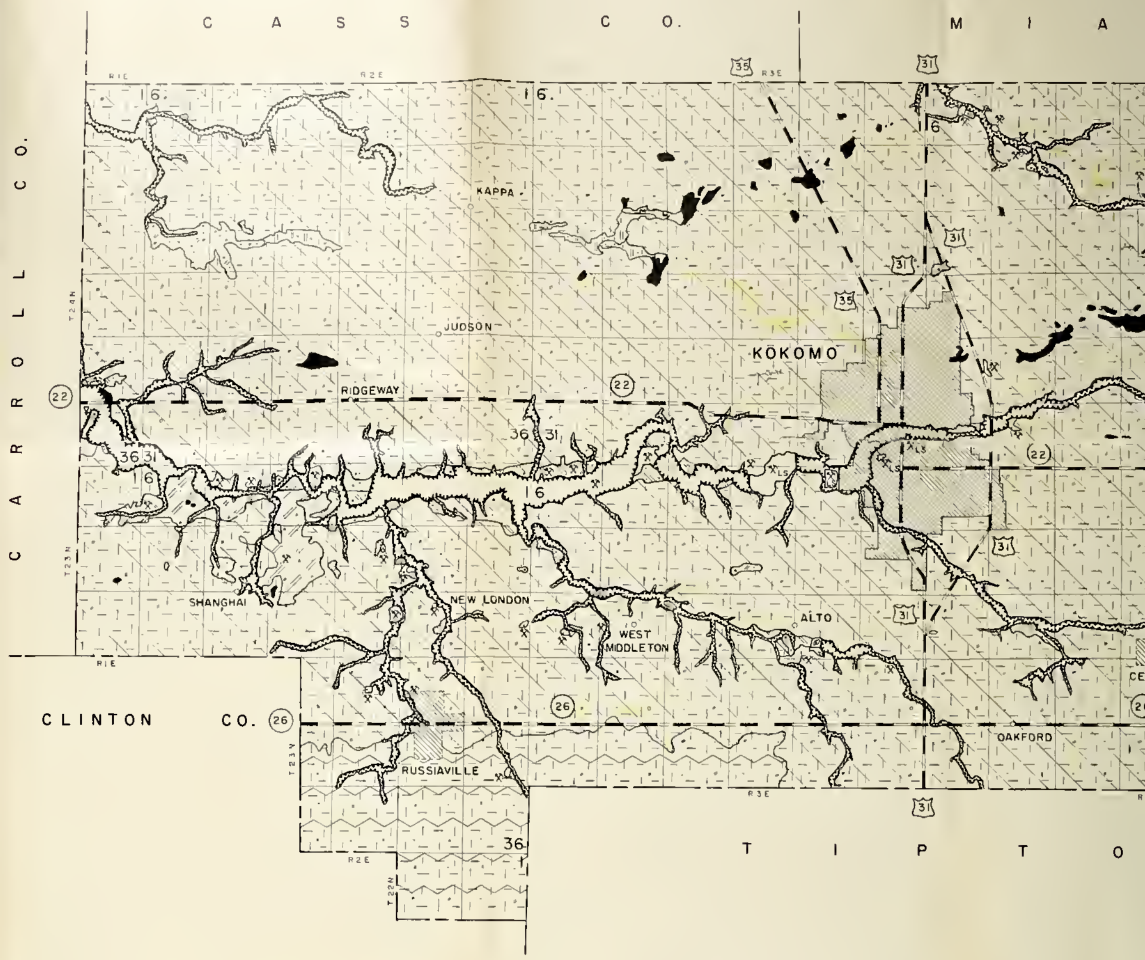
TABLE III (Continued)

Soil Series	Depth From Surface Inches	Classifications USDA	Unified	AASHO	Percentage Passing Sieve #4	#10	#40	#200	Max. Dry Density lb/cu. ft	Opt. MC %	LL %	PI %
Mahalasville *	0-14	sicl.	CL or OL	A-6	100	95-100	90-100	80-90	--	--	--	--
	14-30	sicl.	CL	A-6 or A-7	100	95-100	90-100	80-90	--	--	--	--
	30-55	scl. or cl.	SC or CL	A-2 or A-6	100	95-100	85-95	30-95	--	--	--	--
	55+	stratified sand & silt	ML	A-4	100	95-100	95-100	90-100	--	--	--	--
Miami (modal)	0-7	sil.	ML - CL	A-4(8)	99	98	95	84	101	21	27	4
NWSE 29.T24N, R4E	11-20	c.l.	CL	A-6(9)	99	95	87	64	114	15	36	19
Howard Co.	27-48	loam (till)	ML	A-4(4)	94	88	77	53	128	10	16	2
Miami	0-7	sil.	ML - CL	A-4 or A-6	100	99	97	86	105	19	32	10
NWNE 8 T24N, R4E	7-17	c.l.	CL	A-6(9)	98	92	86	65	110	17	37	17
Howard Co.	32-56+	loam (till)	SC	A-4(3)	92	86	76	49	131	10	22	9
Morley (modal)	0-10	sil.	ML - CL	A-4(8)	--	100	97	85	106	18	32	7
NENE 31 T30N. R12E	16-25	sicl.	ML - CL	A-7-6(13)	--	100	97	77	101	21	46	19
Allen Co.	29+	sicl. (till)	CL	A-6(9)	--	100	94	81	112	17	33	13
Morley (composite of	0-10	sil.	ML to CL	A-4 & A-6	99-100	98-100	93-97	75-85	93-108	14-24	28-47	6-15
5) 3 Allen Co., 2	10-34	sicl. or clay	CL & CH	A-6 & A-7-6	99-100	92-100	88-98	77-87	99-105	19-22	40-55	19-31
Delaware Co.	21-60+	Sicl. (till)	CL	A-6 & A-7-6	86-100	83-100	76-96	65-85	108-120	13-17	29-44	13-24
Needham *	See estimated values for Mahalasville											
Ockley (modal)	0-7	sil.	CL	A-4(5)	99	99	90	60	113	16	26	9
SWSW 35, T13N, R5E	27-35	sicl.	SC	A-7-6(9)	84	82	62	45	107	18	60	42
Shelby Co.	46-60	gravel & sand	SP - SM	A-1-a(0)	58	44	25	8	135	8	NP	NP
Ockley (composite of	0-8	sil.	CL or OL	A-4	96-99	94-99	85-90	54-60	109-113	16	26-32	9
modal and SWNE 14, T13N,	16-35	c.l.	SC	A-7-6	84-88	77-82	41-62	38-45	107-110	16-18	47-60	27-42
R5E	46+	sand & gravel	SP - SM or SM	A-1 to A-2-4	58-92	44-83	25-44	8-15	117-135	8-12	NP	NP
Pewamo (modal)	0-6	sicl.	CH	A-7-6(13)	100	99	98	90	94	25	50	18
NWSW 9, T22N, R10E	19-34	sicl. or sic.	ML - CL	A-7-6(17)	99	98	96	88	111	16	49	28
Delaware Co.	45-56+	sicl.	CL	A-6(11)	94	90	84	72	114	13	38	19
Pewamo (composite of 5)	0-24	sicl.	ML to CL or OH	A-7-6	100	99-100	96-98	81-90	99-103	20-22	37-44	11-27
3 Allen Co., 2	6-60	sicl.	CL to CH	A-7-6	98-100	98-100	95-98	81-88	101-111	16-20	37-52	18-33
Delaware Co.	32-96	sicl. (till)	CL	A-7-6 & A-6	94-100	90-100	84-96	72-85	106-117	13-20	24-42	10-24
Rifle over 42" acid fibrous peat	0-42+	Peat variable substrate	Pt	None	No engineering values for peats and mucks. Must be removed and backfilled with select material before suitable for construction.							
Rodman *	0-7	gravelly loam	ML	A-4	70-80	70-80	65-75	50-60	--	--	--	--
	7-12	grav. loam to cl.	CL	A-6	75-80	75-80	60-70	60-70	--	--	--	--
	12+	strat. sand & gravel	GP or SP	A-1	50-80	35-70	15-30	0-10	--	--	--	--

Soil Series	De Su In	Opt. MC %	LL %	PI &
Russell *	0	--	--	--
	10	--	--	--
	40	--	--	--
		--	--	--
Shoals *	0	--	--	--
Layers of sand & silty sand below 40"		--	--	--
Sloan sil. *	Se			
Sloan sicl. *	0	--	--	--
	15	--	--	--
	36	--	--	--
		--	--	--
Tawas 12-42" thick on sand	0	l before suitable for construction.		
Westland	4	18	48	25
SWSE 26. T12N. R6E	21	18	44	27
Shelby Co.	50	8	NP	NP
Whitaker *	0	--	--	--
	10	--	--	--
	32	--	--	--
		--	--	--
Xenia *	0	--	--	--
	12	--	--	--
	36	--	--	--
		--	--	--

TABLE III (Continued)

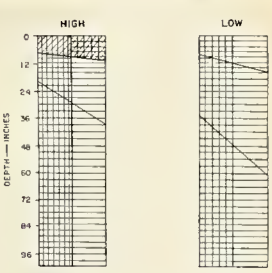
Soil Series	Depth from Surface Inches	Classifications USDA	Unified	AASHO	Percentage Passing Sieve #4	#10	#40	#200	Max Dry Density Lb/cu. ft	Opt. MC %	LL %	PI &
Russell *	0-10	sil.	ML	A-4	100	100	95-100	85-95	--	--	--	--
	10-40	sicl.	CL	A-6	100	100	90-100	80-90	--	--	--	--
	40-50	cl. to loam	CL or ML	A-6	100	95-100	75-85	70-80	--	--	--	--
	50+	loam till	ML or CL	A-4 or A-6	100	85-95	70-80	60-70	--	--	--	--
Shoals *	0-40	sil.	ML or OL	A-4	100	95-100	95-100	85-95	--	--	--	--
Layers of sand & silty sand below 40"	40+	sil. & layers of sand & s.l.	ML	A-4	100	95-100	90-100	75-85	--	--	--	--
Sloan sil. *	See estimated values for Shoals											
Sloan sicl. *	0-15	sicl.	CL or OH	A-6	100	95-100	90-100	85-95	--	--	--	--
	15-36	sicl.	CL	A-6	100	95-100	90-100	85-95	--	--	--	--
	36-55	sicl. to scl	CL	A-6	100	95-100	85-95	50-80	--	--	--	--
	55+	variable	ML or CL	A-4 or A-6	95-100	90-100	80-90	50-90	--	--	--	--
Tawas 12-42"	0-25	Muck			No engineering values for mucks.							
thick on sand	25+	loamy sand	SP or SM	A-1 or A-3	Must be removed and backfilled with select material before suitable for construction.							
Westland	4-11	sicl. or loam	SC	A-7-6(8)	97	90	73	49	105	18	48	25
SWSE 26, T12N, R6E	21-45	sicl.	CL	A-7-6(12)	95	90	79	60	109	18	44	27
Shelby Co.	50-60	sand & gravel	SP - SM	A-1b(0)	72	53	28	9	132	8	NP	NP
Whitaker *	0-10	sil.	ML	A-4	100	95-100	95-100	85-95	--	--	--	--
	10-32	sicl.	CL	A-6	100	95-100	90-100	85-95	--	--	--	--
	32-50	scl.	SC	A-2 or A-4	100	95-100	80-90	30-40	--	--	--	--
	50+	strat silt & sand	ML or SM	A-4	100	95-100	90-100	70-80	--	--	--	--
Xenia *	0-12	sil.	ML	A-4	100	95-100	95-100	85-95	--	--	--	--
	12-36	sicl.	CL	A-6	100	95-100	90-100	80-90	--	--	--	--
	36-48	cl.	CL	A-6	100	95-100	75-85	65-75	--	--	--	--
	48+	loam	ML or CL	A-4 or A-6	100	85-95	70-80	60-70	--	--	--	--



GENERAL SOIL PROFILES

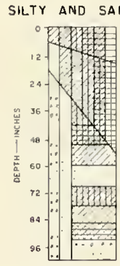
RIDGE AND GROUND MORAINE

CLAYEY TEXTURE



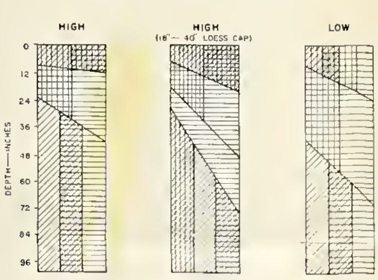
ALLUVIAL PLAINS

SILTY AND SANDY

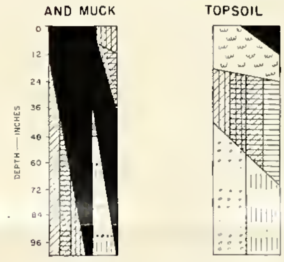


RIDGE AND GROUND MORAINE

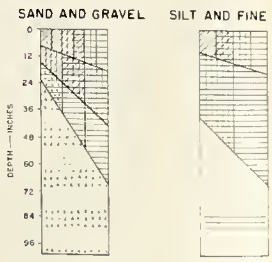
CLAYEY TO SILTY TEXTURE



MISCELLANEOUS



TERRACES AND OUTWASH PLAINS



SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution: Gravel % Retained on #10	Sand % Retained #10-#200	Silt % Retained 0.05-0.005mm	Clay Less than 0.005mm	Plastic Index
Gravel	85-100	0-15	0-10	0-10	NP
Sandy Gravel	50-85	15-50	0-10	0-10	6 Max.
Sand	0-15	85-100	0-10	0-10	NP
Gravelly Sand	20-49	45-85	0-10	0-10	6 Max.
Sandy Loam	0-19	50-80	0-50	0-20	6 Max.
Sandy Clay Loam	0-19	50-30	0-30	20-30	10 Max.
Sandy Clay	0-19	55-70	0-15	30-45	11 Min.
Loam	0-19	30-50	30-50	0-20	10 Max.
Silt Loam	0-19	0-50	50-100	0-20	10 Max.
Silty Clay Loam	0-19	0-30	70-100	20-30	11 Min.
Silty Clay	0-19	0-15	55-70	30-45	11 Min.
Clay Loam	0-19	20-50	50-80	20-30	11 Min.
Clay	0-19	0-55	0-55	30-100	11 Min.
Peat or Muck					
Organic Matter					
Top Soil					

Classification of Gravelly Soils

85%-100% gravel plus finer material - Gravel
50%-84% gravel plus finer material - Clayey, silty or sandy gravel
20%-49% gravel plus finer material - Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%-19% gravel plus finer material - Use fine classification only

ENGINEERING SOILS MAP
HOWARD COUNTY
INDIANA

BY

JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1969

SCALE OF MILES

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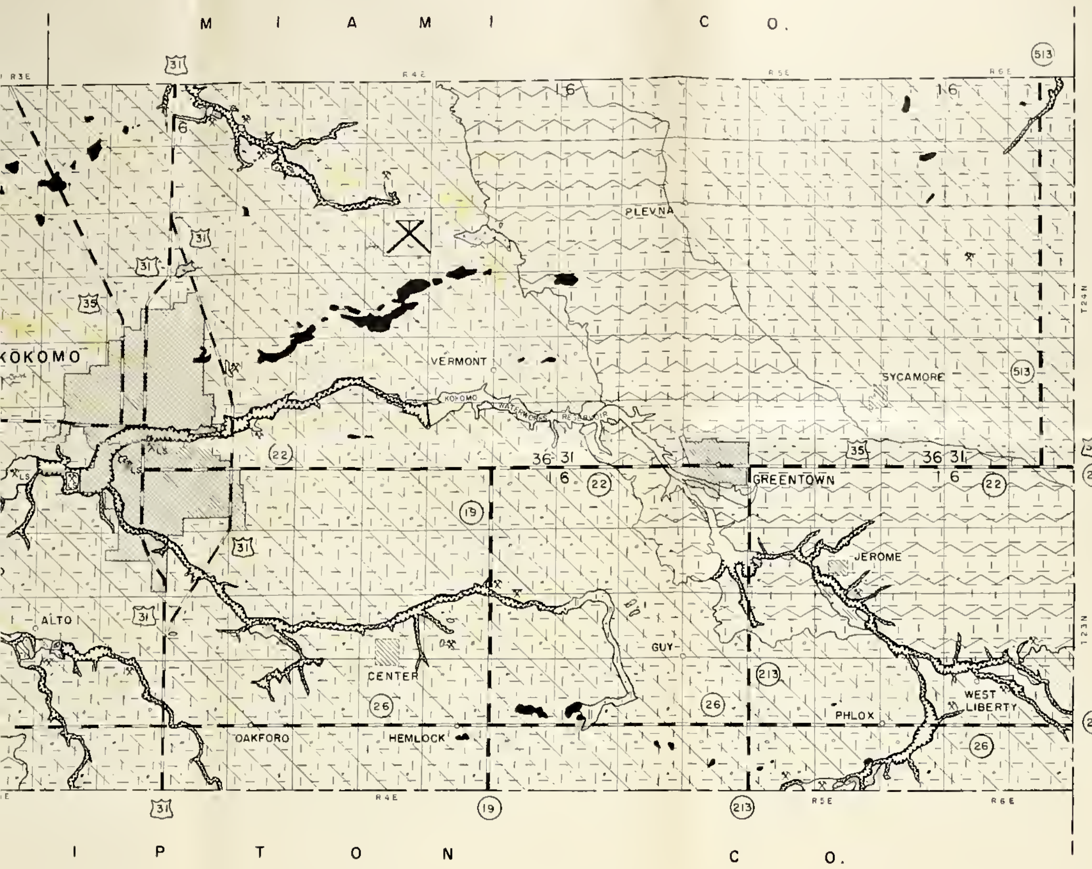

LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- WISCONSIN RIDGE MORAINE
- WISCONSIN GROUND MORAINE
- ALLUVIAL PLAIN
- TERRACE
- OUTWASH PLAIN
- ESKER OR KAME
- PEAT AND MUCK

MISCELLANEOUS

- GRAVEL PIT
- LIMESTONE QUARRY
- HIGHLY ORGANIC TOPSOIL

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

- GRAVEL
- SAND
- SILT
- LOAM

SOIL CLASSIFICATION AND PROFILE SYMBOLS

Grain Size Distribution: Gravel (… ained on #10)	Sand % Retained #10–#200	Silt % Retained 0.05–0.005mm	Clay Less than 0.005mm	Plastic Index	Symbol
85–100	0–15	0–10	0–10	NP	
5U–85	15–50	0–10	0–10	6 Max.	
U–15	85–100	0–10	0–10	NP	
20–49	45–85	0–10	0–10	6 Max.	
0–19	50–90	0–50	0–20	6 Max.	
0–19	50–30	U–30	20–30	10 Max.	
0–19	55–70	0–15	30–45	11 Min.	
0–19	30–50	30–50	0–20	10 Max.	
0–19	0–50	50–100	0–20	10 Max.	
0–19	0–30	70–100	20–30	11 Min.	
0–19	0–15	55–70	30–45	11 Min.	
0–19	20–50	50–80	20–30	11 Min.	
0–19	0–55	0–55	30–100	11 Min.	

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only

ENGINEERING SOILS MAP
HOWARD COUNTY
INDIANA

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AT

PURDUE UNIVERSITY

1969

SCALE OF MILES

1 0 1 2 3 4